BEARING CAPACITY OF CLEAN SAND REINFORCED BY BENTONITE AND RED CLAY

Compiled as one of the requirements of completing the undergraduate program at the department of civil Engineering Faculty

By:

WASEEM W I WARASNEH

D10A153010

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by:

WASEEM.W.I.WARASNEH

D10A153010

Has been checked and approved

by:

Supervisor

AntoBudi.L.ST.MCS

NIK:913

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By:

WASEEM.W.I.WARASNEH

D10A153010

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Muhammadiyah University of Surakarta
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WASEEM.W.I.WARASNEH

D10A153010

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Abstrak

Masalah keruntuhan tanah adalah hambatan nyata dalam pembangunan proyek dan masalah ini yang ada untuk membangun bandara Yogyakarta di pantai di kota Yogyakarta. Jadi harus diperiksa dan dipelajari tanah di laboratorium dan tahu bagaimana membuat tanah memiliki kekuatan yang diperlukan untuk membangun bandara, yang diperlukan pekerjaan uji kimia untuk mengetahui keberadaan pozzolan dan uji fisik yang meliputi mengukur kadar air dan Gravitasi spesifik dan Analisis Saringan dan tes Hydrometer adalah untuk menentukan butiran tanah, dengan menambahkan Bentonit dan tanah liat Merah, dengan persentase telah ditambahkan 5%, 7,5%, 10%. dan akhirnya uji CBR yang mengukur kekuatan tanah dan jumlah yang dibutuhkan untuk menambahkan bentonit dan tanah liat merah dan air untuk membuat tanah memiliki kekuatan, Hasil tes uji kimia menunjukkan adanya pozzolan di tanah liat merah dan bentonit sesuai dengan keberadaan bahan berikut: SIO2 + AL2O3 + Fe2O3, dan hasil untuk kadar air dengan menambahkan Bentonit dan tanah liat merah telah meningkat dengan Persentase dan hasil untuk gravitasi spesifik dengan menambahkan Bentonit dan tanah liat merah telah berkurang dengan Persentase Uji Umum Hasil Untuk Analisis Saringan dan Uji Hydrometer untuk tanah liat merah Bentonit hubungan telah meningkat dan Uji CBR menunjukkan bahwa semakin banyak Bentonit, Tanah Liat Merah dan air ditambahkan, dan semakin banyak pukulan, tanah akan menjadi lebih kuat.

Kata kunci; Daya Dukung, pasir bersih, Bentonit, Tanah liat merah

Abstract

The problem of the collapse of the soil is a real obstacle in the construction of projects and this problem that existed to build the airport Yogyakarta on the coast in the city of Yogyakarta. So must be examined and studied the soil in the laboratory and know how to make the soil have the necessary strength to build the airport, which required the work of chemical test to find out the presence of pozzolan and physical test which includes measuring moisture content and specific gravity and Sieve Analysis and Hydrometer test is to determine the soil grain , with added Bentonite and Red clay ,with percentage has been added 5% ,7.5%,10% . and finally CBR test which measures the strength of the soil and the amount needed to add bentonite and red clay and water to make the soil the soil have the strength ,The test results of the chemical test show the presence of pozzolan in both Red clay and bentonites according to the presence of the following materials:SIO2+AL2O3+Fe2O3, and the result for moisture content by adding Bentonite and red clay has increased with Percentage and result for the specific gravity by adding Bentonite and red clay has decreased with Percentage General Test Result For Sieve Analysis and Hydrometer Test for Bentonite red clay the Relationship has increased and The CBR test shows that the more Bentonite, Red Clay and water are added, ,and more blows ,will be soil more strong .

Keyword: Bearing Capacity , clean sand ,Bentonite , Red clay

1. INTRODUCTION

1.1 New Yogyakarta Airport

The increasing mobility of people who move from one place to another, either by moving the domicile or only for implementing a purpose, from year to year has increased. Not miss out Indonesia is famous for island countries certainly transportation mode air is one of the easiest and fastest mode of transportation by plane that stopped at the airport. One of the airports that are in Indonesia is the Adi Sucipto airport located in Sleman, Yogyakarta. From its inception to the present Adi Sucipto airport, the airport is not only used for commercial flights, but also used as a home base and runway military activities.

New development projects Yogyakarta Internatioanl Airport later will only be a commercial airport and be the largest airport in Indonesia in 2018. New development projects Yogyakarta Internatioanl Airport in the village Jangkaran, Sindutan, Palihan, Kebonrejo, and Glagah in Temon, Kulon Progo, and Yogyakarta.

With the airport area which spans 587.3 hectares the airport is expected to have a hangar measuring 371 125 meter2 square planned could accommodate as many as 28 aircraft, the construction project is expected to be able to accommodate passengers at Adi Sucipto airport in Yogyakarta has been predicted no longer able to accommodate the demand for passenger flights, as well as ease of access for users transportasion air Yogyakarta and surrounding areas.

the project development location of the New Yogyakarta International Airport t is in the coastal area or called the beach. the beach type of land is pure sand. pure sand is a soil that has a fine size and has a small cohesive level. in addition to the soil conditions on the coast, the groundwater level conditions in the progo kulon area are near the surface.

New International Airport airport terminal building uses bore pile foundation, bore pile was chosen because it has a high friction force than using pile foundation, besides that the process of making bore pile is very applicable according to field conditions where soil conditions are pure sand soil.

Bore pile foundation work process using a heavy equipment called a drilling machine that can drill up to> 10 meters. the process of making bore pile foundation on the construction project of the Jogjakarta Airport New International terminal by drilling the ground using a drilling machine to reach the desired depth. Foundation drilling for bore pile on the new international

airport project jogkjakarta airport occurred a landslide when the drill tool left the foundation pit. this is because the type of pure sand soil has a small cohesive force and a high ground water table so that it creates water pressure on the walls of the excavation so that it occurs in the excavation hole. To overcome this, the PP KSO as the executor of the New International Airport airport uses slurry are bentonite and red clay, to prevent it on Landslides caused by groundwater pressure and the small cohesive force of pure sand. in this study the California Bearing Capacity (CBR) test on pure sand has been given bentonite and red soil to obtain pure sand end bearing after being given slury. hence the student raised the title "Bearing Capacity of CBR sand land".

And Sandy is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

Bentonite Is a combination of sodium bentonite and slurry. A slurry is a thin sloppy mud or cement or, in extended use, any fluid mixture of a pulverized solid with water, often used as a convenient way of handling solids in bulk.

Red clay slurry are defined as mineral soils which contain no calcareous (calcium carbonate containing) material anywhere within the soil, have less than 10% weatherable minerals in the extreme top layer of soil, and have less than 35% base saturation throughout the soil.

Bearing Capacity is the capacity of soil to support the loads applied to the ground. The bearing capacity of soil is the maximum average contact pressure between the foundation and the soil which should not produce shear failure in the soil.

Subgrade is is the native material underneath a constructed road, pavement or railway track (US: railroad track). It is also called formation level.The term can also refer to imported material that has been used to build an embankment .

And The testing of bearing capacity of ratio includes testing specific gravity ,moisture content, Atterberg boundaries, and grains of soil grading .

1.2 Specific Gravity

Specific Gravity is defined as the ratio of the density of a given substance, to the density of water (H_2O). Substances with a specific gravity greater than 1 are heavier than water, and those with a specific gravity of less than 1 are lighter than water. In equation form :

$$\boldsymbol{Gs} = \frac{\boldsymbol{\gamma s}}{\boldsymbol{\gamma w}} \quad \text{.....(1)}$$

1.3 Moisture Content (w)

Moisture content of soil describes the amount of water present in a quantity of soil in terms of its dry weight. In equation form :

$$\boldsymbol{w = \frac{Ww}{Ws} \times 100\%} \quad \text{.....(2)}$$

1.4 Atterberg Limit

Atterberg limit describes the consistency and plasticity of fine-grained soils with varying degrees of moisture content. For the portion of the soil passing the No. 40(0.425 mm) sieve, the moisture content is varied to identify three stages of soil behavior in terms of consistency. These stages are known as the liquid limit (LL), plastic limit (PL) and shrinkage limit (SL) of soils.

1.5 California Bearing Ratio

The California bearing ratio test was first developed by California division of highways in 1929 as a means of classifying the suitability of a soil for use as subgrade or base course material in highway construction. During World War II, the US corps of engineers adopted the test for use in airfield construction, civil engineering handbook by W.F.CHEN 1936 pg 665.In equation form:

$$CBR = \frac{\text{test unit load}}{\text{Standard unit load}} * 100 \quad \text{.....(3)}$$

2. RESERCH METHOD

2.1 General

The core idea of this research is to determine the California bearing ratio of soil , The California Bearing Ratio (CBR) has been acknowledged as an important parameter to characterize the bearing capacity of earth structures, such as earth dams, road embankments, airport runways, bridge abutments and pavements. Technically, the CBR test can be carried out in the laboratory or in the field. The CBR test is time-consuming and is infrequently performed due to the equipment needed and the fact that the field moisture content keeps changing over time. Over the years, many correlations have been developed for the prediction of CBR by various researchers, including the dynamic cone penetrometer, undrained shear strength and Clegg impact hammer. This paper reports and discusses some of the results from a study on the prediction of CBR. In the current study, the CBR test was performed in the laboratory on some fine grained subgrade soils collected from various locations in Victoria. Based on the test results,

a satisfactory empirical correlation was found between the CBR and the physical properties of the experimental soils.

2.3 Research Location

The research location is planned and executed at Soil Mechanics Laboratory of Civil Engineering Department, Muhammadiyah University of Surakarta. Sand soil sample is coming from Yogyakarta ,Indonesia .

2.4 Flow chart of research

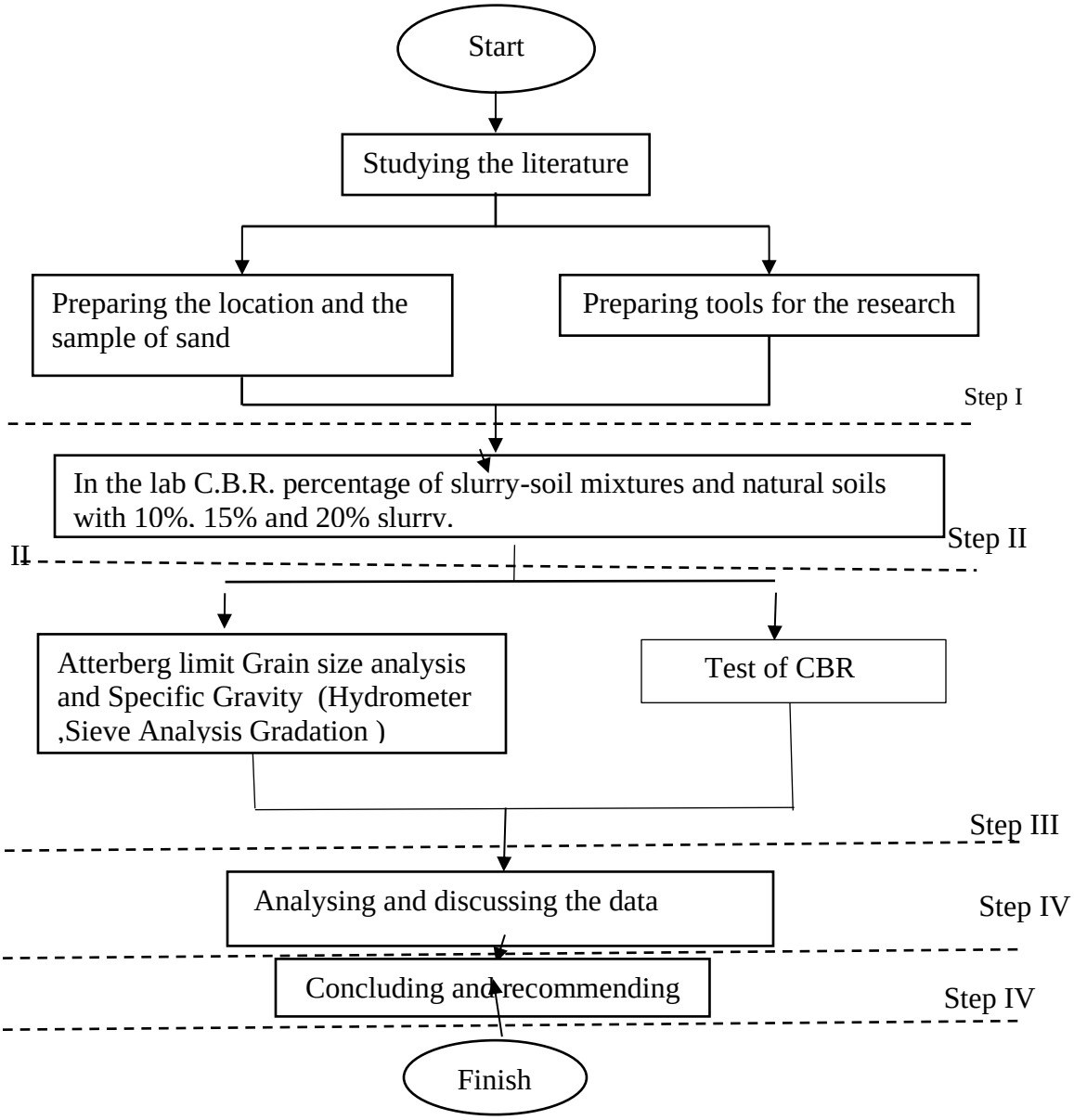

Figure.1. Flow chart of research

3 ANALYSIS AND DISCUSSION

3.1 Chemical Test

3.1.1 Sandy

Table 1. the value of Chemical test in Sandy soil

Component	the results	Standard Deviation	Unit
O2*	25,51	0,89	mass%
Al2O3	12,29	0,37	mass%
SiO2	38,67	0,38	mass%
K2O	0,963	0,028	mass%
CaO	7,181	0,057	mass%
TiO2	1,874	0,023	mass%
MnO	0,252	0,006	mass%
Fe2O3	13,14	0,11	mass%
CuO	195,9	8,6	mass%
ZnO	232,7	7,7	mass%
Rb2O	38,9	1,1	mass%
SrO	395,0	5,1	mass%
ZrO2	118	11	mass%
BaO	206,6	8,5	mass%

From the analysis of the table, the chemical test for sandy shows the presence of pozzolan and this is because of the presence of SiO2 and which is =38,67,also the presence of Al2O3 =12,29,also the presence of Fe2O3 =13,14 so sandy contains this content of SiO2+ Al2O3+ Fe2O3 Also, sandy soils contain high content of SiO2+ Al2O3+ Fe2O3 , which makes the presence of pozzolan in sandy soils

3.1.2 Bentonite

Table 2. the value of Chemical test in Bentonite

Component	the results	Standard Deviation	Unit
O2*	32,20	0,80	mass%
Al2O3	11,16	0,30	mass%
SiO2	43,56	0,43	mass%
Cl	0,151	0,002	mass%
CaO	2,080	0,023	mass%
TiO2	0,953	0,013	mass%
MnO	0,100	0,003	mass%
Fe2O3	9,691	0,079	mass%
CuO	3366	7,0	mass%
ZnO	204,6	8,2	mass%
SrO	332,4	7,4	mass%
BaO	128,7	6,3	mass%

From the analysis of the table, the chemical test for Bentonite shows the presence of pozzolan and this is because of the presence of SiO2 and which is =43,56,also the presence of Al2O3 =11,16,also the presence of Fe2O3 =9,691 so Bentonite contains this content of SiO2+ Al2O3+ Fe2O3 Also, Bentonite contain high content of SiO2+ Al2O3+ Fe2O3 , which makes the presence of pozzolan in Bentonite .

3.1.3 Red clay

Table V .1. the value of Chemical test in Red Clay

Component	the results	Standard Deviation	Unit

O2*	25,00	0,77	mass%
Al2O3	28,79	0,36	mass%
SiO2	32,96	0,38	mass%
CaO	0,392	0,015	mass%
TiO2	1,155	0,011	mass%
MnO	0,183	0,004	mass%
Fe2O3	11,37	0,11	mass%
CuO	334,6	9,8	mass%
ZnO	196	12	mass%
AsO3	55,9	2,7	mass%
SrO	106,3	2,2	mass%
ZrO2	72,0	3,6	mass%
Y2O3	200,9	9,2	mass%
BaO	591	13	mass%

From the analysis of the table, the chemical test for red clay shows the presence of pozzolan and this is because of the presence of SiO2 and which is =32,96,also the presence of Al2O3 =28,79,also the presence of Fe2O3 =11,37 so red clay contains this content of SiO2+ Al2O3+ Fe2O3 Also, red clay contain high content of SiO2+ Al2O3+ Fe2O3 , which makes the presence of pozzolan in red clay.

3.2 Physical Test

Physical Test is an important soil test that includes moisture content and specific gravity , sieving analysis, The Physical test is to test the soil by knowing the condition of the soil in mixing it with Slurry ,so the result for moisture content by adding Bentonite has increased with Percentage and same for red clay the Relationship has increased between moisture content with percentage increased and result for the specific gravity by adding Bentonite has decreased with Percentage , and same for red clay the Relationship has decreased between specific gravity with percentage , so the Relationship has decreased and General Test Result For Sieve Analysis and Hydrometer Test for red clay the Relationship

has increased between moisture content with percentage increased,for bentonite has increased with Sieve Diameter , and The CBR test shows that the more Bentonite, Red Clay and water are added, ,and more blows ,will be soil more strong , so the addition of Slurry is a powerful factor to overcome soil weakness.

3.2.1 Moisture Content

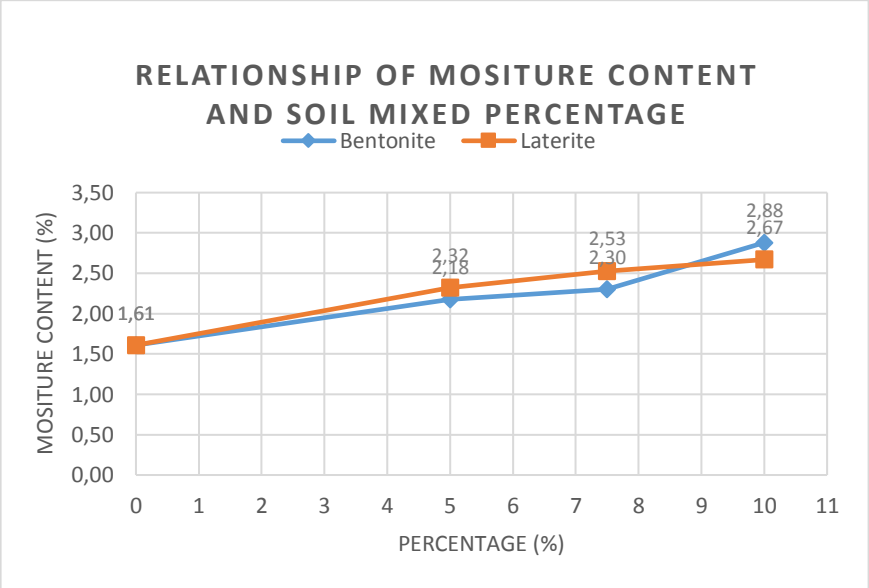

Figure .2. the value of Moisture content test in Bentonite and Red Cl

From the analysis of the curve, the moisture content by adding Bentonite has increased with Percentage , so the value of moisture content for sand =1.61 ,and when added Bentonite 5% =2.18 , Bentonite 7.5% =2.30 , Bentonite 10% =2.88 ,so the Relationship has increased. and same for red clay the Relationship has increased between moisture content with percentage ,so the value of moisture content for sand = 1.61, and when added red clay 5% =2.32 , Bentonite 7.5% =2.53, Bentonite 10% =2.67 ,so the Relationship has increased .

3.2.2 Specific Gravity

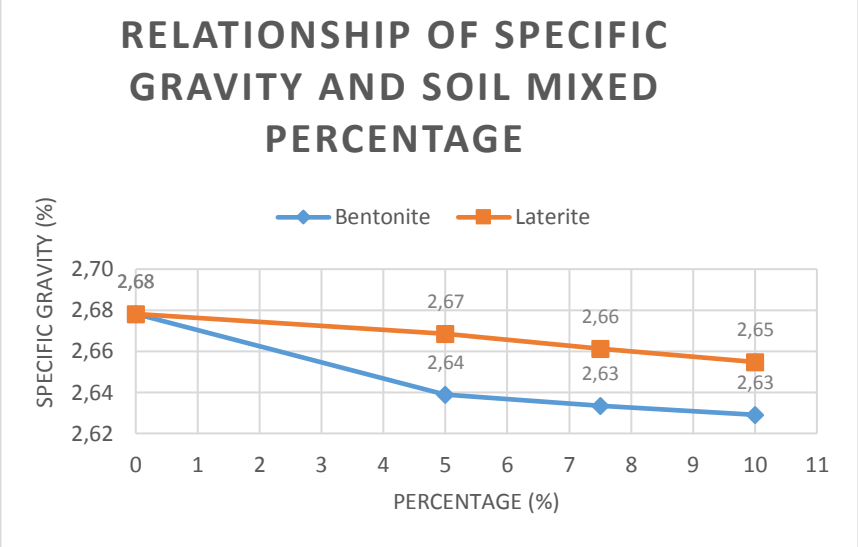

Figure .3. the value of Specific Gravity test and Soil Mixed Percentage

From the analysis of the curve, the specific gravity by adding Bentonite has decreased with Percentage , so the value of specific gravity for sand =2.68 ,and when added Bentonite 5% =2.64 , Bentonite 7.5% =2.63 , Bentonite 10% =2.63 ,so the Relationship has decreased. for red clay the Relationship has decreased between specific gravity with percentage ,so the value of specific gravity for sand = 1.61, and when added red clay 5% =2.67 , Bentonite 7.5% =2.66, Bentonite 10% =2.65 ,so the Relationship has decreased .

3.3 Sieve Analysis and Hydrometer Test

3.3.1 General Test Result For Sieve Analysis and Hydrometer Test

The aim of the Sieve Analysis and Hydrometer test is to determine the soil grain , with added Bentonite and Red clay ,with percentage has been added 5% ,7.5%,10% .

3.3.2 Sieve Analysis and Hydrometer Test for Red clay

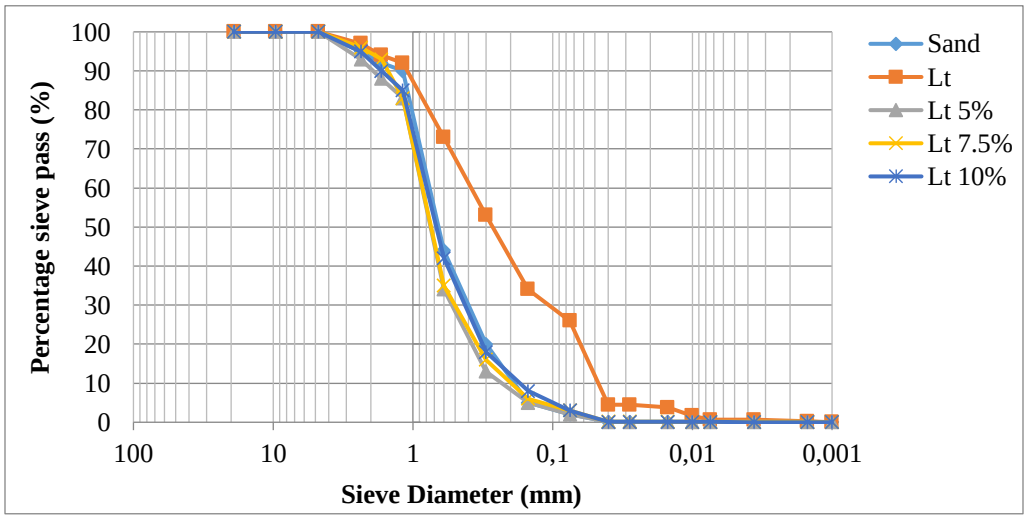

Figure .4. the value of Red Clay between percentage sieve pass (%) and Sieve Diameter

From the analysis of the curve, the percentage sieve pass by adding Red clay has increased with Sieve Diameter , so the value of percentage sieve pass No 200 for sand = 2 ,and when added Bentonite 5% = 2 , Bentonite 7.5% = 3, Bentonite 10% = 3,so the Relationship has increased

3.3.3 Sieve Analysis and Hydrometer Test for Bentonite.

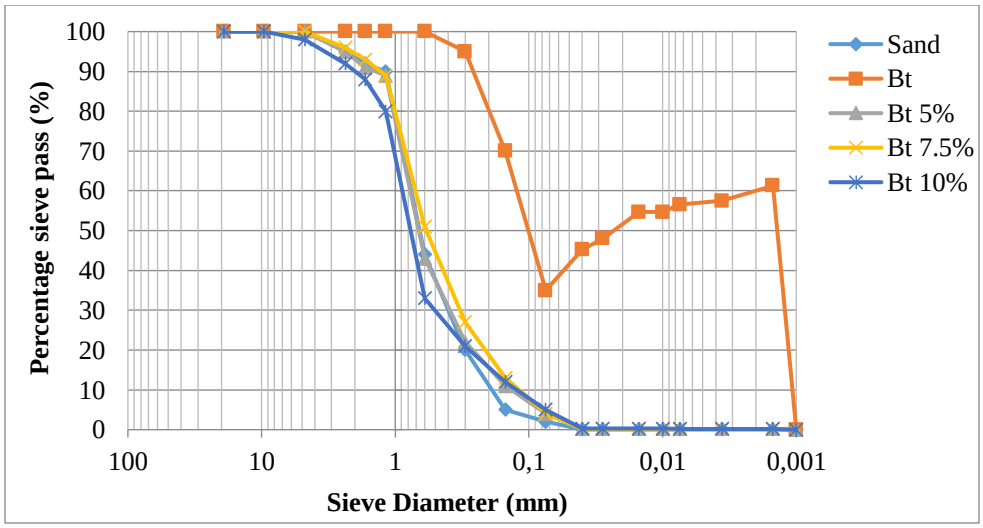

Figure .5. the value of Bentonite between percentage sieve pass (%) and Sieve Diameter (mm)

From the analysis of the curve, the percentage sieve pass by adding Bentonite has increased with Sieve Diameter , so the value of percentage sieve pass No 200 for sand =1.61 ,and when added Bentonite 5% = 4 , Bentonite 7.5% = 4 , Bentonite 10% = 5 ,so the Relationship has increased. There is amazing value in 100% for Bentonite Sieve analysis and Hydrometer test which has been increased in the value for test ,because the Bentonite test It has water absorption property and also can expand eight times (megawati,2008).

3.4 CBR TEST

3.4.1 General Test Result For Bentonite In 56 Blows

The CBR tests have to be with different amount of water content and different percentage of slurry mix and the different technique of compaction. Air-dried water content getting to be the reference for all testing phases. According to the data obtained ,the soil with Bentonite is better than the soil with Red Clay ,and the more slurry and water with soil becomes more solid and more cohesive soil .The value of CBR test in 56 x blows in Bentonite is the best data .

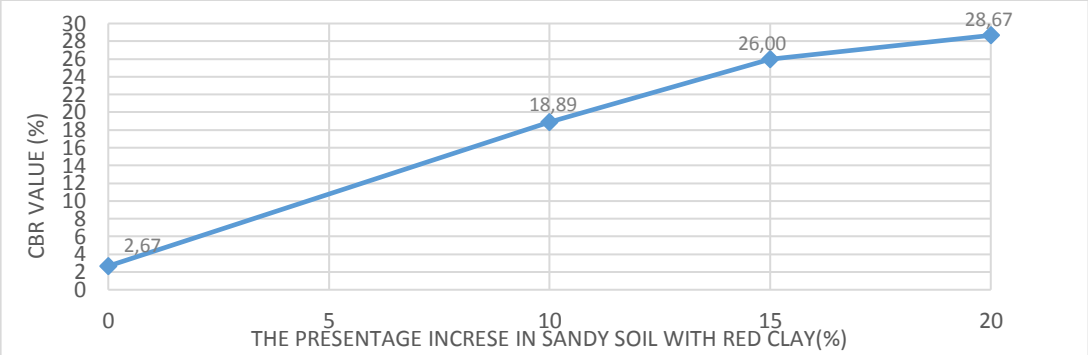

Figure .6. the value of CBR test in 56 x blows in Bentonite

From the analysis of the curve, the CBR by adding Bentonite has increased, so the value of percentage CBR for sand = 2,67 ,and when added Bentonite 10% =18.89 , Bentonite 15% = 26.00, Bentonite 20% = 28.67,so the Relationship has increased, because the more the ratio of water and Bentonite added for sandy soil, and the soil becomes more strong , As we can see from the curve, the increase of blows to 56 led to an increase in bonding cohesion and stronger for sandy soil when it was over 30 blows. Through the curve for Bentonite in 56 blows has the sandy soil more strong than the Red Clay in 56 blows .

4. CONCLUSION

The test results of the chemical test show the presence of pozzolan in both Red clay and bentonites according to the presence of the following materials:SIO2+AL2O3+Fe2O3, and for the physical test data for the moisture content by adding Bentonite has increased with Percentage , so the value of moisture content for sand =1.61 ,and when added Bentonite 5% =2.18 , Bentonite 7.5% =2.30 , Bentonite 10% =2.88 ,and same for red clay the Relationship has increased between moisture content with percentage ,so the value of moisture content for sand = 1.61, and when added red clay 5% =2.32 , Bentonite 7.5% =2.53, Bentonite 10% =2.67 and the specific gravity by adding Bentonite has decreased with Percentage , so the value of specific gravity for sand =2.68 ,and when added Bentonite 5% =2.64 , Bentonite 7.5% =2.63 , Bentonite 10% =2.63 ,and same for red clay the Relationship has decreased between specific gravity with percentage ,so the

value of specific gravity for sand = 1.61, and when added red clay 5% =2.67 , Bentonite 7.5% =2.66, Bentonite 10% =2.65 Sieve Analysis and Hydrometer test is to determine the soil grain , with added Bentonite and Red clay ,with percentage has been added 5% ,7.5%,10% , the percentage sieve pass by adding Red clay has increased with Sieve Diameter , the percentage sieve pass by adding Bentonite has increased with Sieve DiameterThere is interesting value in 100% for Bentonite Sieve analysis and Hydrometer test which has been increased in the value for test ,because the Bentonite test It has water absorption property and also can expand eight times .finally CBR test is give the solution of the weak soil lies in the addition of slurry ,which makes the soil able overcome the problem of soil weakness and he increase of slurry and water added to the soil works to strengthen the soil more and more .

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